Arizona Roving in an Afternoon

Patrick Stoddard, WD9EWK/ VA7EWK
Board Member
patrick@wd9ewk.net

I have been active on satellites – at home and away – for over 15 years. Roving has been a part of my operating since almost the beginning. Whether on road trips out of state (or outside the USA), day-trips to locations in and around Arizona, or the Walmart Parking Lots on the Air events in 2018 and 2019 from many locations in the Phoenix area – this is fun. When Endaf, N6UTC, asked about getting some new Arizona grids for his activity around the DM06/DM16 grid boundary in California on 27 February 2021, I came up with a plan for that day....

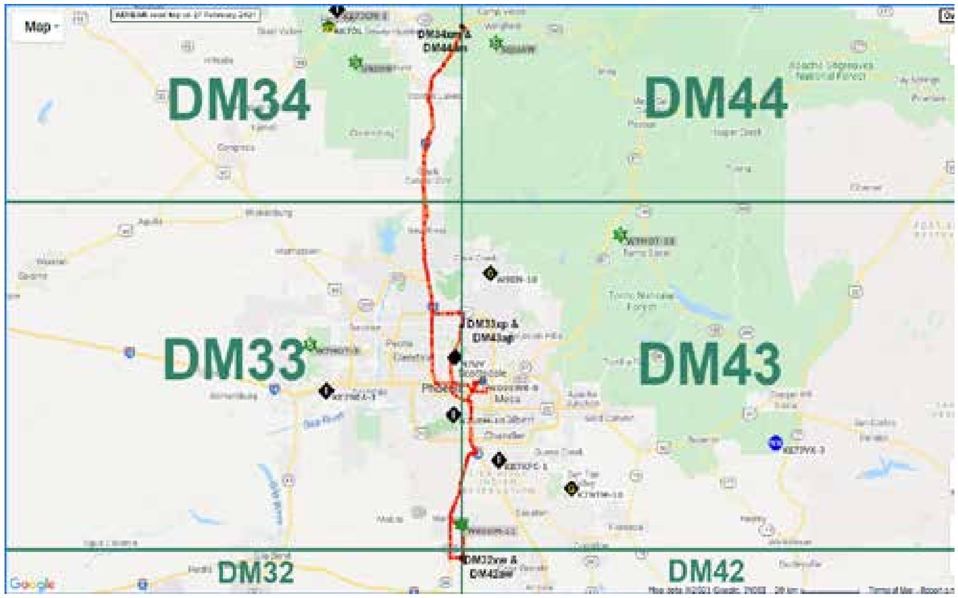
Arizona straddles 112 degrees west, which is the dividing line between a few grids. In Phoenix, this line separates grids DM33 and DM43. I live a few miles east of the DM33/ DM43 line and have many thousands of satellite contacts from a Phoenix city park on that line. North of Phoenix, the DM34/ DM44 line is very close to I-17, about halfway between Phoenix and Flagstaff. The DM32/DM42 grid boundary is in farmland south of the metro Phoenix area, less than an hour away. I took advantage of this geography and planned to visit 3 different grid boundaries along 112 degrees west on this trip:

- DM34/DM44 line – south of Camp Verde AZ, along AZ-169, west of I-17 exit 278
- DM33/DM43 line – in a city park in northeast Phoenix, near the AZ-51/ AZ-101 interchange
- DM32/DM42 line – southeast of Maricopa AZ, east of AZ-347

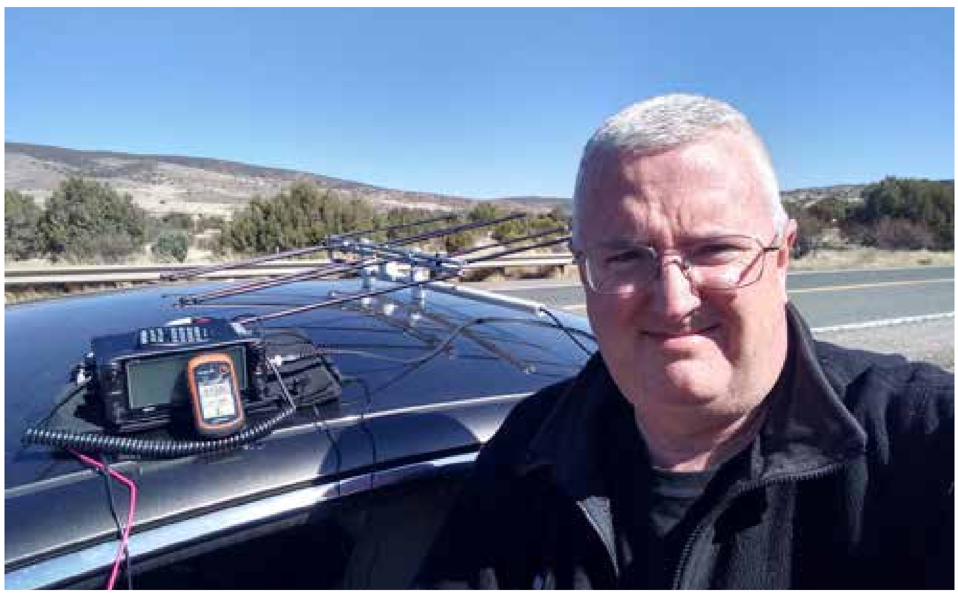
N6UTC and I identified five passes that could be worked during the afternoon of 27 February, while he was in the DM06/ DM16 area in California:

- SO-50 at 1901 UTC
- NO-84 at 1929 UTC
- SO-50 at 2044 UTC
- PO-101 at 2056 UTC
- PO-101 at 2232 UTC

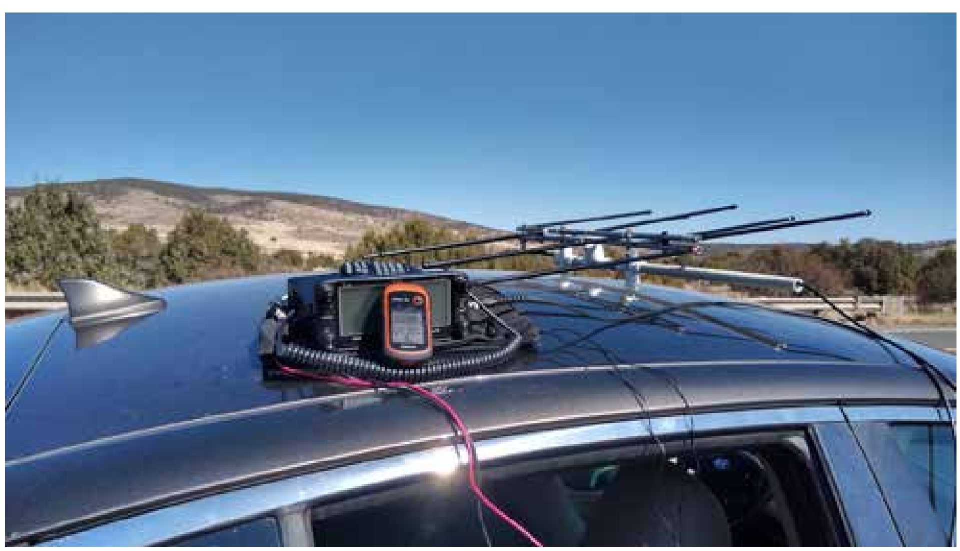
Given the distances between these three locations, along with the pass times, I decided to start north of Phoenix. I would begin at the DM34/DM44 line for the



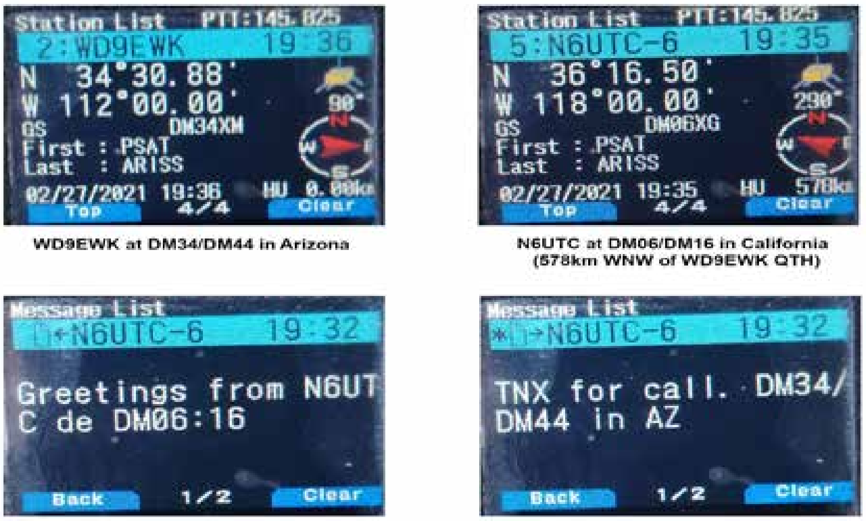
Road trip map.



At DM34/DM44.



NO-84 packet QSO between WD9EWK and N6UTC - 27 February 2021



WD9EWK at DM34/DM44 in Arizona

N6UTC at DM06/DM16 in California (578km WNW of WD9EWK QTH)

N6UTC called WD9EWK first...

... and WD9EWK replied. The "*" in the upper-left corner shows N6UTC's radio received my message.

Station	
Call Sign	WD9EWK
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM34XM,DM44AM
State	Arizona (AZ)
County	Yavapai
Worked Station	
Worked	N6UTC
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM06,DM16
State	California (CA)
County	Inyo
Date/Time	2021-02-27 19:02:00
Mode	FM (PHONE)
Band	2M
Frequency	145.85000
Receive Band	70CM
Receive Frequency	436.79500
Propagation Mode	SAT
Satellite	SO-50
QSL	2021-02-28 05:00:05

Record ID 1314098467 **Received:** 2021-02-28 04:23:21

Station	
Call Sign	WD9EWK
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM34XM,DM44AM
State	Arizona (AZ)
County	Yavapai
Worked Station	
Worked	N6UTC
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM06,DM16
State	California (CA)
County	Inyo
Date/Time	2021-02-27 19:32:00
Mode	PACKET (DATA)
Band	2M
Frequency	145.82500
Receive Band	2M
Propagation Mode	SAT
Satellite	NO-84
QSL	2021-02-28 05:01:11

Record ID 1314098472 **Received:** 2021-02-28 04:23:22

Station	
Call Sign	WD9EWK
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM33XP,DM43AP
State	Arizona (AZ)
County	Maricopa
Worked Station	
Worked	N6UTC
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM06,DM16
State	California (CA)
County	Inyo
Date/Time	2021-02-27 20:57:00
Mode	FM (PHONE)
Band	70CM
Frequency	437.50000
Receive Band	2M
Receive Frequency	145.90000
Propagation Mode	SAT
Satellite	PO-101
QSL	2021-02-28 05:06:12

Record ID 1314098646 **Received:** 2021-02-28 04:23:31

Station	
Call Sign	WD9EWK
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM32XW,DM42AW
State	Arizona (AZ)
County	Pinal
Worked Station	
Worked	N6UTC
DXCC	UNITED STATES OF AMERICA (291)
CQ Zone	03
ITU Zone	06
Grid	DM16
State	California (CA)
County	Inyo
Date/Time	2021-02-27 22:35:00
Mode	FM (PHONE)
Band	70CM
Frequency	437.50000
Receive Band	2M
Receive Frequency	145.90000
Propagation Mode	SAT
Satellite	PO-101
QSL	2021-02-28 05:13:16

Record ID 1314098724 **Received:** 2021-02-28 04:23:36

LOTW QSOs with N6UTC.

SO-50 and NO-84 passes in the 1900 UTC hour and then drive back to Phoenix for the second SO-50 pass and the first PO-101 pass in the park on the DM33/DM43 line. After the stop at the park, I would drive south of the Phoenix area to the DM32/DM42 line for the second PO-101 pass. As I drove around central Arizona, I would transmit my location to the APRS network on 144.390 MHz, a way to ensure N6UTC could keep track of where I was (and others, too).

From my house, the DM34/DM44 line along AZ-169 is about 90 minutes away. I left home just after 1700 UTC and made it to the spot with time to spare. I parked on the wide shoulder along the highway at that point, took pictures of my station – an Icom ID-5100 2 m/70 cm mobile radio, an Elk log periodic, and a Garmin GPS receiver to document my location, and waited for SO-50 to come up from the southwest.

This SO-50 pass was an overhead pass in Arizona and a high pass for N6UTC in central California. N6UTC went in my log early in the pass, and I logged five other contacts with stations across much of the continental US, and a pleasant surprise at the end of the pass – John, VE1CWJ, in Nova Scotia. I had a nice view between hills to the northeast, allowing me to work SO-50 closer to the horizon near my LOS time. After SO-50 went away, I scribbled the contacts in my logbook.

Even with the SO-50 contact in the logbook, N6UTC and I wanted to try NO-84 for another contact. We both enjoy making satellite contacts using packet through the orbiting digipeaters, and the NO-84 pass was good for both of us. We worked each other, and I worked the other two stations I heard on the pass (KB6LTY in southern California, K7TEJ in the Phoenix area). I logged these NO-84 contacts, stowed my gear in the car, and went back to Phoenix for the next two passes on the DM33/DM43 line.

The drive back to Phoenix took about an hour. I arrived at the Phoenix city park just as the 2045 UTC SO-50 pass was starting. I did not hear N6UTC on that pass but worked a couple of stations in the last few minutes of the pass. I put the PO-101 frequencies in the ID-5100 and was ready for that pass. My first contact on that pass was N6UTC, and I proceeded to work four other stations. N6UTC was also busy working stations from his location on the DM06/DM16 grid boundary.

After PO-101, I quickly put my gear away, and drove south to the DM32/DM42 line.

This drive typically takes around 45 minutes, but on this day took over an hour. Two traffic accidents on AZ-347 brought traffic to a crawl. Instead of having a half-hour or more to prepare for the last PO-101 pass, I arrived at the DM32/DM42 line about 10 minutes before starting that pass.

The spot on the DM32/DM42 line I chose is along a road in the middle of farmland, east of AZ-347, and west of the sprawling Nissan Technical Center North America complex. This was the first time I tried this particular location on the grid line in Pinal County instead of parking along a state highway south of here or on another road on an Indian reservation north of here. I took some pictures at this spot and waited for PO-101 to come up from the horizon.

When PO-101 came up, I heard KJ7COA in Washington state and made a quick contact with him. Then N6UTC appeared, and we worked each other. A few other stations were on later in the pass; both N6UTC and I made additional contacts.

After these five passes, our goal was met. N6UTC made contacts from DM06/DM16, picked up new grids from other stations and me, and I operated from three locations in six different Arizona grids in less than four hours. When I returned home, I saw that I drove 273 miles. This trip took about six hours in total, from when I left my driveway until parking back in the driveway. This was the first time I took my ID-5100 out to work satellites away from home, and it performed very well.

I have operated from spots on these grid boundaries in the past, but this was the first time I visited these six grids on one trip in one afternoon. It was fun! 73!

Design and flight results of the VHF/UHF communication system of Longjiang lunar microsatellites

- **Mingchuan Wei,**
- **Chaoran Hu,**
- **Daniel Estévez,**
- **Mier Tai,**
- **Yuhao Zhao,**
- **Jiahe Huang,**
- **Cees Bassa,**
- **Tammo Jan Dijkema,**
- **Xibin Cao &**
- **Feng Wang**

Nature Communications volume, 11, Article number: 3425 (2020).

Abstract

As a part of China's Chang'e-4 lunar far side mission, two lunar microsatellites for low frequency radio astronomy, amateur radio and education, Longjiang-1 and Longjiang-2, were launched as secondary payloads on 20 May 2018 together with the Queqiao L2 relay satellite. On 25 May 2018, Longjiang-2 successfully inserted itself into a lunar elliptical orbit of 357 km × 13,704 km, and became the smallest spacecraft which entered lunar orbit with its own propulsion system. The satellite carried the first amateur radio communication system operating in lunar orbit, which is a VHF/UHF software defined radio (SDR) designed for operation with small ground stations. This article describes and evaluates the design of the VHF/UHF radio and the waveforms used. Flight results of the VHF/UHF radio are also presented, including operation of the radio, performance analysis of downlink signals and the first lunar orbit UHF very-long-baseline interferometry (VLBI) experiment.

Introduction

Longjiang-1 and Longjiang-2 are a pair of lunar micro-satellites for low-frequency radio astronomy, amateur radio, and education, developed by Harbin Institute of Technology, as a part of the Chang'e-4 lunar far side mission1. The satellites, each with a volume of 765 × 420 × 570 mm3 and a mass of ~47 kg, were launched into a lunar transfer orbit on 20 May 2018 by a CZ-4C rocket as secondary payloads, together with the Queqiao L2 relay satellite. Unfortunately, Longjiang-1 was lost because of a malfunction of thruster control logic during the first trajectory correction maneuver (TCM). The logic on Longjiang-2 was later patched, and after 113 h of flight since launch, the satellite successfully inserted itself into a lunar elliptical orbit of 357 km × 13704 km, and became the smallest spacecraft which entered lunar orbit independently.

Besides the S-band and X-band radios operated by the Chinese Deep Space Network (CDSN), Longjiang-1 and Longjiang-2 were equipped with identical VHF/UHF radios for amateur radio experiments and backup tracking, telemetry, and command (TT&C). The radio onboard Longjiang-2 is the first radio communication system operating on amateur radio bands that was placed into lunar orbit.

Radio amateurs have been building and tracking satellites since 1961[2]. Nowadays, many small satellites developed for universities and technology development projects use amateur radio frequencies and AX.25 link layer protocol[3,4]. With the development of the Internet, several global satellite tracking networks have been developed by radio amateurs, for example SatNOGS[5]. Besides that, radio amateurs around the word use the Moon as a natural reflector for moonbounce, or Earth–Moon–Earth (EME) communication. For these purposes, radio amateurs operate a large number of high gain antennas around the world, forming a possible non-governmental, non-commercial deep space network, though the size of antennas is relatively small. VHF/UHF is among the most popular bands used for EME.

Before Longjiang-2, several satellites operating on amateur radio bands have been launched into deep space, including UNITEC-1 (trans-Venus, Japan, 2010)[6], Shin'en2 (heliocentric orbit, Japan, 2014)[7], ARTSAT2-DESPATCH (heliocentric orbit, Japan, 2014)[8], and 4M-LXS (lunar flyby, Luxembourg, 2014)[9]. These satellites used CW or JT65 modulation schemes for data downlink because of the low demodulation thresholds of these modes, but the data rates are too low (<10 bps) for payload data, so only transmission of some very basic housekeeping data is possible. UHF frequencies, some of which are allocated to the amateur satellite service, are widely used by deep space missions for inter-probe proximity links, for example the link between China's Chang'e-3 lander and Yutu rover, and NASA's Electra proximity